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ABSTRACT

The primary aim of this research project was to assist elementary classroom teachers in developing and using appropriate techniques for assessing and recording their students' achievement in science (taught as a core subject or as part of an environmental studies topic). The project was designed with the intention of providing a supportive structure in which teachers felt free to explore and develop their own personal methods of assessment and record keeping. The second aim of the project was to provide instructional materials to serve as a basis for advisors, consultants, or course leaders to assist teachers in improving their assessment skills in science. Sixteen teachers in eight schools in the Fife Region of Manitoba (Canada) participated in the project, which ran from February to July of 1987. In addition to detailing the project's overall methodology, the report supplies four case studies and describes five issues in assessment identified in the course of the experiment. The results of the project indicated that with support and guidance teachers will develop and use their own individual assessment techniques in elementary science. Thirty-two references are included, and each of the teachers' techniques for assessment is briefly summarized in an appendix. (TW)

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Classroom-based Diagnosis and Assessment in Primary Science

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> Assessment in education has been criticized for interfering with the process of learning, the analogy being that of a gardener constantly pulling up his plants to see if the roots are growing. There is some truth in this, particularly if there is too much assessment of the wrong kind, but it also distorts reality to make a point. Gardeners do have to find out if their plants are growing and they do this, not be uprooting them, but by careful observation with a knowledgeable eye, so that they can give water and food at the right times and avoid either undernourishment or over-watering. Similarly, assessing children's educational development is an essential part of fostering that development, of teaching, so that both short and long-term planning of activities can match the stages reached and provide optimum opportunities for further learning.
>
> (Harlen, 1983, p. vii)

The main aim of this project was to provide a supportive structure so that classroom teachers could explore, develop and evaluate suitable techniques for assessing and recording pupil achievement in Primary Science (taught as a separate subject or in the context of Environmental Studies).

PRIMARY SCIENCE ASSESSMENT

Assessment of Science Learning

The science education literature is replete with reports of studies in which test materials have been developed. Doran (1978) summarized the progress of science educators in this field. One is struck by the plethora of paper and pencil tests and the emphasis on the assessment of content knowledge, particularly in the sixties and seventies. In the eighties a new emphasis has emerged, the assessment of process skills, either by pencil and paper or by

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practical means (Dillashaw and Okey 1980, Bryce et al. 1983, Padilla, Cronin and Tweist 1985, Leith 1985, and the work of the APU 1981-85). Much of this work has been specifically developed for the purpose of monitoring achievement on a large scale. Rarely were the teachers in the classroom involved or consulted to any extent. There has been little emphasis on assisting teachers to develop assessment techniques for their personal use.

Classroom-based Assessment in Science

As a result of a recent movement towards accountability in education several assessment schemes have been developed for use in science classrooms. One of the most comprehensive is the OCEA scheme (Oxford Certificate of Educational Achievement, Science, 1987). This has been developed for use at middle and secondary schools in England. It provides detailed assistance for the inservice training of teachers and includes a prescribed scheme for pupil assessment.

Several recently published science teaching programs include assessment procedures to be used as an integral part of the teaching process (Warwick Process Science, 1987; Science in Process [Heinmann], 1987; and Science Through Topics, [Longmans], 1986). All suggest that the teachers follow the prescribed scheme, not develop their own methods.

A book on general assessment in the classroom by Black and Broadfoot (1982) provided some excellent background material and rationale for assessment at the primary school. From their illustrative example of Hilltop Primary School, several lessons can be learned: the necessity for recording the achievements

of each child in relation to each part of the syllabus; the need for a method of individualized diagnostic assessment which will gather critical information about pupils' learning; the need for a quick, efficient, easily accessible and cumulative record system; and finally the concern for having records which deal with the child's non-academic, personal and social development.

Dr. Wynne Harlen has provided a firm foundation for the consideration of classroom assessment in primary science. Her two books, Guides to Assessment in Education: Science (1983), and Teaching and Learning Primary Science (1985) review the whole field and are excellent sources for information on the purposes and methods of assessing children, defining criteria for use in assessment, types of day to day assessment in primary science, and keeping and using records of achievement.

Other materials, notably the Durham County Council pamphlet, An Assessment Strategy and the Aberdeen College of Education pamphlet, Teaching Primary Science, Unit 6, Management Skills in Planning for Science, provide thought-provoking background and examples relative to science assessment.

Three documents, published in Scotland and dealing with general issues in educational assessment, provide a context from which the particular problems of assessment in primary science may be viewed. These documents, Issues in Educational Assessment (1979), What do they know? A Review of Criterion-Referenced Assessment (1980), and Assessment Purposes, A Study of the Relationship between Diagnostic Assessment and Summative Assessment for Certification (1986) are invaluable for anyone contemplating a project on assessment.

Official Scottish Documents Relating to Primary Science Assessment

Since 1980 several documents have been published in Scotland which reiterate the need for assessment, as enunciated earlier in Primary Education in Scotland, Part 2, Chapter 8 (1965). Learning and Teaching in Primary 4 and Primary 7 (1980) reported on a survey conducted by HMI's, and outlined the assessment and reporting methods found in the classrooms. Learning and Teaching: The Environment and the Primary School Curriculum (1984) reviewed the possible subject matter which might be involved in environmental studies programs, and highlighted the need for assessment and record keeping. The discussion paper, Education 10-14 in Scotland (1986) placed considerable emphasis on the importance of assessment and record keeping as an integral part of the school program.

Assessment in Thematic/Project Work

Considerable attention has been paid to the assessment of project and thematic work by classroom teachers. As part of the ORACLE (Observation Research and Classroom Learning Evaluation) project based in Leicester, Leith (1981) described a research study in which a group of teachers was provided with a project assessment sheet developed by a previous teacher group. They agreed to try out the checklist for several months and report their opinions of it. When contacted at the end of this period no teachers were using the checklist. The author put forward several explanations -- possibly the cumbersomeness of the list or alternately, perhaps teachers will not use checklists which they do not develop themselves, or perhaps they do not feel that project work needs to be formally assessed.

Wray's book (Teaching Information Skills Through Project Work, 1985) described four case studies in which the assessment of the pupils' project work was an integral part. Subsequently he suggested several methods of assessment and record keeping.

A research project, TAIPS (Thematic Assessment in Primary Schools) was begun at Moray House in Scotland in 1985. The main emphasis of the project was "to identify what teachers were doing and what assessment difficulties they were encountering within their thematic work" (p. 1). Their main findings, relative to assessment, at the end of Stage 1, were that although teachers are engaged in daily assessment by observation and questioning, they did not perceive this as assessment, and also that teachers had very complex aims for thematic work, which were not easily translated into assessment procedures. Stage 2 of the project evolved as a result of these and other findings. A multiplicity of assessment techniques emerged as commonly used by teachers. By the end of Stage 3 some suggestions for a basic assessment grid had emerged but with the proviso that each grid being tailored to the specific teaching situation.

Assessment in Primary Science & Environmental Studies in Scotland

Three projects which involve the development of assessment in classrooms in the eighties will be described. They all contribute unique aspects to the problems facing teachers. The Primary Science Development Project (1983) produced several booklets for teachers to be used as an aid in the development of a school policy and program in primary science. The booklet, Assessment, Evaluation and Record Keeping provided a rationale for assessment and described several forms of assessment and examples of record keeping.

The project, Practical Assessment of Environmental Studies (1985), had a different purpose, that of developing practical assessment materials specific to certain strands and themes in environmental studies. Twelve booklets of assessment activities were developed.

The Primary Education Development Project is still under development. Curricular packages for environmental themes are being produced and will have assessment suggestions as an integral part. Hopefully, a general model for assessment will be produced.

RESEARCH PROCEDURE

Aims of Research

The primary aim of this research project was to assist primary classroom teachers to develop and use appropriate techniques for assessing and recording their children's achievement in Science (taught as a core subject or as part of an Environmental Studies topic). The methodology of the project was such as to provide a supportive structure in which teachers felt free to explore and develop their own personal methods of assessment and record keeping. At no time did the researcher prescribe any particular techniques; the teachers were free to select from a variety presented or develop unique ways of their own.

The second aim of the project was to provide instructional materials to serve as a basis for advisors, consultants, or course leaders to assist teachers to improve their assessment skills in science.

Methodology

The research project took place from February through to July 1987. Initial contacts with the Scottish Education Department and the Fife Regional Council, Education Department were made during December, 1986 and January, 1987. A summary of the methodology used in the research project is given below:

1. The researcher initially met with the Mrs. Anne Watters, the Assistant Organiser: Science for the Education Department and the Fife Regional Council to ascertain the needs of the primary teachers in the region with respect to Primary Science. For those schools with established Primary Science or Environmental Studies programs it was identified that assessment was the next priority for them.

2. With the aid of Mrs. Watters, a number of schools was identified in which there were established primary science/environmental studies programs and which would be receptive to the project. From these the researcher selected 10 which were conveniently located and presented a varying type and size.

3. The Head Teachers of these schools were visited and the project was explained to them. At this stage they made the decision as to whether they wished teachers in their schools to be involved. Eight out of the 10 Head Teachers agreed and began to identify teachers who would work with the researcher. Sixteen teachers in eight schools were selected. In two cases they were the Head Teachers in two small schools.

4. The researcher arranged for meetings with the teachers at each school separately, because the present climate of teacher action (work-to-rule)

prevented getting them together for an initial all day seminar as originally planned.

5. At each meeting the researcher discussed issues related to assessment in Primary Science, outlined possible techniques, provided supporting materials, books and a videotape. No teachers were practising any type of assessment or recording in Primary Science/Environmental Studies before starting this project.

6. During the time between the first and second meetings with the teachers at each school, the teachers read the materials and discussed their concerns with each other and in some schools with their Heads and/or Assistant Head Teachers.

7. The researcher met biweekly at each school with the teacher groups and spent time in the classrooms while the teachers were teaching their science lessons. In one case the researcher went with a class of children to a museum and in two other instances took groups out into the playground for science activities. Advice was given, when asked for, on general issues in science teaching.

8. Teachers began to develop and use the assessment techniques of their choice. Some modified the examples provided by the researcher, while others developed unique methods after considering their own classrooms and conditions. Seven of the teachers involved were teaching composite classrooms with two or more levels of instruction. Much time was spent by all as they deliberated and explored ways of meeting their unique situations.

9. Videotapes were made by the researcher of science lessons in classrooms

during a week in May. Science classes were videotaped in those classrooms where the teacher was still involved in teaching the Science/ Environmental Studies unit, and where they were willing to be videotaped. In all, it was possible to videotape 10 lessons, six at Primary 1 to 3 and four at Primary 4 to 7.

10. An all day seminar for the teachers involved in the project was held on June 22 at Valley School in Kirkcaldy. Because of the inability in obtaining relief teachers for all the teachers involved, just 11 out of the total of 16 teachers were able to attend the seminar. As well as these six Head Teachers and Assistant Head Teachers attended for varying periods during the day. The program of the seminar consisted of a summary report by the researcher, a description by each teacher present of her assessment method and an evaluation of this method. Much discussion occurred as these reports were being given. After lunch the edited videotapes were shown of the science lessons in the 10 classrooms. A brief discussion followed and plans for the some school wide assessment records were broached.

11. The schools were visited at the end of the term and samples of teacher assessment methods were gathered to incorporate into a summary report. Teachers were probed on their attitudes toward assessment and their experiences during the five months relative to the research project.

RESULTS

In spite of the short time in which the research project ran (February to July) the results were very encouraging. Much thought and effort was put into their

work by all the teachers involved and the results were diversified and interesting. New ground was broken by some and significant modifications were made in other work. This research pointed out that with support and guidance teachers will develop and use assessment techniques in Primary Science.

Teachers' Initial Reactions

Initially most of the teachers were rather apprehensive and in one case, slightly hostile, to the idea of them assessing their pupils in Primary Science/Environmental Studies. All said that they were already assessing the children in Reading and Mathematics with numerous checklists and mandated tests and wasn't that enough? Most wondered why it would be necessary to assess their children's Science work as they were already very busy. In only one school, at the initial meeting with the teachers, was the idea of developing assessment materials received without reservation. This was in a small school where the Head Teacher was taking an Open University course on Reading in which there was course work on assessment. This Head Teacher welcomed the opportunity to explore the idea of developing assessment measures in Primary Science.

Much of the researcher's time in the initial meetings was spent in trying to allay the fears of the teachers. First of all, it was difficult for them to understand that nothing was being prescribed for them. The project's aim was to have teachers explore and study the possible ways of assessing their children and then to have them try out a method which appealed to them. Secondly, they needed time to read the materials and the book (Guides to Assessment in Education: Science by Dr. W. Harlen) provided and to discuss the

ideas with each other. In the schools where the Head Teachers and/or Assistant Head Teachers took an active part, this process was speeded up and the benefit was obvious at all stages.

Science Policies in Project Schools

Whether or not the school had a policy for Primary Science/Environmental Studies did not seem to be closely related to how the teachers undertook the assessment project. Three schools had a definite policy for Science/Environmental Studies with topics suggested on a yearly basis. The other schools had no policy, but tended to use the Guidelines, Environmental Studies developed by the Fife Region Council Education Committee. Most schools, by the end of the project, felt the need for a school policy for Science/Environmental Studies and those who did not have one hope to develop one in the next year or so.

Teachers' Meetings

Meetings were held after hours in most schools on a biweekly basis. As the term progressed and the idea of assessment in science became more acceptable to the teachers excellent discussions were held at the meetings. A key point was the need to decide the purpose of the assessment. Most teachers agreed that the prime purpose for them was to serve as a diagnostic tool in order that they might identify problems and better match activities to their children's needs. As the project progressed teachers began to see the assessment as way of evaluating their own teaching to see if they were providing adequate opportunities for the children to learn.

Teachers brought their ideas for their assessment techniques to the biweekly meetings and asked for comments on them from their colleagues and the researcher. Many had spent long hours reading the materials supplied and in some cases went to other sources for information. Nearly all tried out their techniques at an early stage and some modified them as they progressed. Only one teacher did not develop a method of written assessment and recording. She felt that because of the demands of her teaching situation she would prefer to spend her time in planning and teaching and keep her assessment of the children's learning in her head rather than written forms of assessment.

Types of Units Taught

Some of the units were developed especially for the project, whereas others were taught as they had been planned in advance of the researcher's coming. Some were of an Environmental Studies nature; others were strictly Science. Many of the teachers sought assistance from the Fife Education Services Centre in Kirkcaldy and/or from the Primary Science Organiser. The researcher attempted to be present in the classroom several times when the actual teaching of the unit was being done so as to get a better feel for the teaching which was the basis for the assessment. Teachers seemed to welcome the researcher's interest in this way.

Assessment Techniques Used

A variety of types and records of assessment was developed and used and are summarized in Tables 1 and 2. Some patterns seemed to emerge. At the Primary 1 to 3 levels there were more informal methods and group assessment sheets and checklists, whereas at the Primary 4 to 7 levels the focus was more on the

achievement of the individual child rather than on the group. However, there were exceptions, as in for school D, teachers 1 and 2 who developed an elaborate unit plan with detailed checklists for their P1 children for each subtopic in the unit. Another teacher at the infant level used her checklist on only one group per topic, saying it was too time consuming to do otherwise. Only one teacher did not use any type of written record.

Each of the teachers' techniques for assessment (as listed in Tables 1 and 2) is briefly summarized in the Appendix.

CASE STUDIES

Case Study #1

School A is a very small school in a little village. There are just over 30 children, with over half of the children with teacher A-1 in P1 to P3, and the remainder with teacher A-2 in P4 to P7. There is a school science/environmental studies policy in which there are rotating topics every year. All the children in each class do the topic which is adjusted to their level. There is also a science club which meets every week after school in which the older children do the British Association for the Advancement of Science (BAAS) Young Investigators series of science investigations.

Teacher A-1. The teacher in charge of teaching the younger children selects science topics which are of short duration. During this research project she has clarified and developed her unique method of teaching and assessing primary science. Her summary and description of her method is as follows:

Children's ideas are important. Investigate, explore these ideas. Encourage children to ask questions and seek answers/ explanations.

Procedure

1. Decide topic to be investigated.
2. Gather children. State the purpose of the activity - get them interested - look around - assess manner of the children - include those who are fidgeting.
3. Show apparatus. Pose problem.
4. Ask children to think ahead - "What do you think will happen? Don't tell anyone what you think." "Go and write this down. Come back quickly." Assess by looking at faces - those who do know, those who have no idea, those who are unsure. Go around, encourage children to be quick.
5. Carry out experiment/demonstration. Assess by making sure all are observing, include any who may be losing interest. Talk, ask questions, let children ask questions. It may be possible at this stage to see who are understanding.
6. Accept children's suggestions for variation of experiment should events not go as planned. Encourage more predictions.
7. Send children to seats for written follow up. Help them set out their pages with diagrams of sequence of experiment plus their written explanations.

From their written explanations and drawings further assessment is possible. After observing what the children write and draw they can be questioned, and clarification of certain points made. Individual children can be brought back to the experiment which can be repeated for their benefit.

When all papers are complete final assessment can be made. The criteria are:

Has the concept been understood by all/few/none?

Will further discussion be of value?

Should the children discuss their ideas in groups?

Keep their papers in folders for future reference.

This teaching and assessment sequence works well for this teacher. Children are stretched in their scientific thinking and instant remedial action is possible. Even the five year olds produce some excellent pictures and explanations.

Teacher A-2. This teacher who works with the older children does two separate types of science activities, work on topics such as Trees, and the Young Investigators' cards. Children are encouraged to work independently and assist each other. The children write up their experiments or fill in work sheets, as appropriate. She monitors their work closely and questions them to help them think more deeply. Conferences are held frequently to discuss any problems that are revealed by observing them working or from their papers.

Case Study #2

School D is a large primary school in a suburban area of a large town. The school, because it is in an economically and socially deprived area, devotes much time to the personal welfare of its students. There is no science or environmental studies policy in the school but plans are being made to develop such a policy. The Head Teacher and Assistant Head Teacher are very supportive of curriculum development and the professional growth of their teachers so gave this research project full support from the very beginning.

Teachers D-1,2. These teachers have a very well organised team teaching situation in their P1 classes. The units of study are planned together and they share the teaching responsibilities. The children are taught to be very independent and move freely about the adjoining two rooms. It is an exemplary

team teaching situation in which the children are greatly benefitting from the talents of these devoted teachers.

Both teachers readily accepted the idea of building assessment techniques into their unit which was to be planned for the summer term. They eagerly read the materials and books provided and discussed their ideas with the Head Teacher, the Assistant Head Teacher, the other teacher involved in the project in the school, and the researcher. They decided that a unit on Animals would give them lots of scope for science activities as well as for language development, mathematics and the arts. The children were divided into eight mixed ability groups and stayed in these groups for several weeks for their science activities. These teachers selected the following 11 skills about which to plan and assess their science activities:

> observing, communicating, recording, predicting/reasoning, investigating, measuring, classifying, co-operation, recall- suggests, answers/discusses confidently, applies learning in a new situation, works independently.

The aims and assessment methods for each of the eight activity groups were:

Aims	Assessment Methods
1. Feeding the guinea pig (to discover what the guinea pig likes [dislikes] to eat)	Completion of daily chart to be transferred to large graph and individual work sheets and story writing activities
2. Finding the guinea pig's weight (to find suitable units of measurement and carry out weekly weighings)	Oral and written - group wall charts and individual records
3. Length of the guinea pig (to estimate and measure the length of Squeak)	Discussion and individual charts for a month
4. Making own fish tank (to name various parts of a fish and their functions)	Large wall frieze will be followed by children completing their sheets

Aims	Assessment Methods
5. Tadpoles to frogs (to observe the sequential development of a frog from spawn)	Classroom display, sequencing story activity
6. What do gerbils like to eat? (to sort which foods the gerbils like - compare with other pets)	Through observation and discussion compile a chart
7. Chicks development (sequence the hatching)	Matching pictures and sentences - place in order
8. Cooking eggs (to find as many ways as possible to cook eggs - then taste)	The actual baking activity and group graph

The teachers recorded the achievement of their pupils on a group assessment sheet on which they used a colour coded system for the three criteria levels they had selected. Comments were also made for each child. Both teachers were very pleased with their system and say that they will continue to use it. It helps identify weaknesses and strengths of each child and is not too time consuming. They believe that it has been an excellent diagnostic tool. They will pass the checklists on to the teacher who will have the children in the subsequent year.

Teacher D-3. This teacher who works with a large class of generally difficult P6 children eagerly accepted the challenge of developing a unit and designing an assessment method to accompany it. She decided on the topic of Ourselves which she branched out into physical education with tests for fitness, speed, and agility. A diary was kept which recorded the activities and thoughts of the teacher throughout the 19 lessons. Much time and careful planning went into this whole project. An interesting aspect was the bulletin board displays

which were built up from the children's work which showed the development of the teaching content and sequence of activities.

Initially the teacher was going to develop and use assessment sheets for each child, but decided that this was too burdensome. The two techniques which she developed and used she considers very successful. They were used for different purposes: the class checklist was used mainly for discussion sessions, whereas the group comment sheet was used to assess their work on investigations. For the checklist she used a four point scale (good, fair, limited, no understanding) and listed 14 criteria as follows:

> understanding, observation, initiative, problem solving, co-operation, perseverance, confidence, critical thinking, verbal reasoning/expression, written activities/recording, curiosity, hypothesising, predicting outcomes, designing experiments.

The group comment sheet was used extensively to record the progress of the children on their investigations. She used mixed ability groups, but changed their constitution frequently and was generally assessing their ability to work independently on the set task and come up with reasonable result.

Case Study #3

School E is a small, one class per level primary school in a small coastal village. The building is fairly new and the school appears to be well equipped. The children are very well behaved and come from mainly middle to upper middle class families. The Head Teacher is very supportive of curriculum development and the professional growth of her staff. The researcher was warmly welcomed as the project was explained to the Head Teacher.

Teacher E-1. The one teacher who was selected from this school to take part in the research project was a probationary teacher completing her second year of teaching. At first she was apprehensive about teaching a science unit and particularly about planning assessment for this unit.
She agreed to take part and undertook to read the materials and book provided. On the second visit she had confirmed her decision to teach a unit on the "Senses" to her P2's and was eager for advice on assessment. She had made a planning web and it was suggested that she write out her objectives for the unit and decide what concepts and skills she wished to assess.

By the next meeting she was well into teaching the unit, now working on "Listening" activities with the children. She had designed her assessment sheet to be used with each group as they rotated through the activities. For each subtopic she made an assessment sheet on which she identified the concepts she expected them to have learned. She made comments beside each child's name as to their understanding of the concepts. She observed them as they worked, listened to their discussion and read their work sheets for the activity.

Although this technique was time consuming as she repeated it for each group for each activity, she found it very worthwhile, stating that she really knew what progress the children were making and was able to make adjustments in her teaching to meet their needs.

Case Study #4

School H is a small three teacher school located in a working class district in a medium sized town. The Head Teacher teachers almost full time. There is a school policy for Environmental Studies in which topics and teaching times are

prescribed. The Head Teacher is very keen on curriculum development and has given curriculum workshops for parents. He welcomed participation in the research project as he is very interested in assessment.

Teachers H-1,2 are the P4/5 and the P6/7 teachers with one being the Head Teacher. Their work will be discussed together because it is mainly through the Head Teacher's lead that the assessment program was developed.

Three different types of sheets were developed, each for different purposes. Firstly, there is a scientific report sheet on which the children write up their investigations. The teachers use this as an indication of the child's understanding of the investigation.

Secondly, there is a group assessment sheet on which the concepts and skills for the topic are listed. The names of the activities and the children's names are indicated. There is a five point scale (1-5) for indicating the achievement level of each child in the group on that particular concept or skill. The criteria for the scale are:

1. Showing no sign of development.
2.
3. Encouraging sign of development.
4.
5. Showing strong positive sign of development.

The third sheet was developed to serve as an Environmental Studies Profile Sheet which will be used throughout the school from P3 upwards. Children would be assessed on these dimensions several times throughout the year and the year end result would be passed on with the child's other records. This profile has a very comprehensive list consisting of nine concepts, eight researching/interpreting experience skills, four recording/experiencing and

feeling skills, and one category each for relationships and positive attitudes. Many of the items on the list have been adapted from The Fife Regional Council Education Committee's Guidelines - Environmental Studies. As well as this, the Head Teacher has developed a very comprehensive list of criteria, on a five point scale for each of the above items.

This comprehensive assessment program for science/environmental studies has been piloted for four months and will be put into practice next autumn for the P 3 to P 7 classes. The Head Teacher is very pleased with the results as he feels that it provides excellent diagnostic and prescriptive information and a complete developmental record for the area.

ISSUES IN ASSESSMENT

Several issues in assessment were clearly identified:

1. Teachers are constantly assessing children whether or not they are recording anything. They must be assured that this is of great value. One must build on their existing competencies, not try to impose a prescribed structure on them.
2. One needs to help teachers see the value of consciously looking for certain identified aspects of their children's learning. A sure way to help them see the value of assessment seems to be "If it is worth giving teaching time to, it is worth assessing."
3. The researcher's main role is supportive and must be seen as one who appreciates the teacher's craft knowledge and who will offer advice when asked for it. The teachers frequently asked what were some possible ways of assessing and what are the other teachers in the project doing.
4. Although the research project focussed on assessment, the teachers were forced to identify their aims for teaching their units more clearly. Few had previously identified the

concepts, skills and attitudes of the work they were planning to teach.

5. Much has to be done by the schools in clarifying the aims of assessment and deciding on school policies for assessment. However, the results of this research project seem to indicate that teachers need time for reflection and freedom to develop their own style of recording their assessment methods, especially when they are doing it for diagnostic purposes. Under this climate teachers will flourish and creative and useful assessment techniques and recording methods will result.

CONCLUSIONS

There were two main aims for this research project:

1. To assist primary teachers to develop and use appropriate techniques for assessing and recording their children's achievement in science (taught as a separate subject or a part of an environmental studies program).

2. To provide instructional materials to serve as a basis for advisors, consultants, or course leaders to assist teachers to improve their assessment skills in science.

The first aim was certainly accomplished. As far as it can be determined no project of this type has ever been done. In spite of the short time in which the research project ran the results were very encouraging. Although most of the teachers were apprehensive at first, they worked very diligently trying to understand the principles involved and soon began to explore ideas and methods of assessment and recording. The researcher offered many suggestions and models for assessment, but did <u>not</u> at any time <u>tell</u> the teachers how to plan their assessment techniques. Fifteen out of the 16 teachers involved in the project developed some form of written assessment and record keeping. Ten

developed some type of checklists and five used comments in a variety of methods. Several original and unique methods of assessing and recording evolved in the course of the project. None adopted checklists or record sheets as they found them in the literature.

All the teachers said that they found working in the project a worthwhile experience. It heightened their awareness of their children's learning and helped them to plan and teach better. Most will use their personally developed assessment methods and recording sheets next year, some in a modified form.

Several schools will be developing an extensive assessment and recording procedure in the next year or two. School H already has this underway.

It is noteworthy that, in all cases, the teachers decided to use mixed ability groups in teaching and assessment groupings, except for a few occasions at the P6 level.

For the second aim a package of materials has been assembled which consists of:

- two videotapes of science classroom teaching, one tape of six P1 to P3 lessons, and another tape of four P4 to P6 lessons, both with annotations and sample sets of the teachers' assessment techniques
- a package of teaching materials and examples of assessment methods
- a list of reference books and pamphlets

Table 1

Primary 1 to 3 Teachers' Types and Records of Assessment

Teacher*	Level	Formal/ Informal	Type of Record	Method of Assessment
A-1	P 1-3	Informal	Folders of work	Children write and draw descriptions of investigations. Teacher makes diagnostic comments.
B-1	P 2	Informal	Anecdotal	Critical comments
C-1	P 3	Formal	Group checklist with each child's name for each subtopic	Three criteria level checks and comments
D-1,2	P1	Formal	Group checklist with each child's name for each subtopic	Three criteria level checks and comments
E-1	P2	Formal	Group checklist with each child's name for each subtopic	Comments
F-1	P1/2	Informal	In head	
C-1	P 3	Formal	Group checklist with each child's name for each subtopic	Three criteria level

* Names of teachers and schools are confidential.

Table 2

Primary 4 to 7 Teachers' Types and Records of Assessment

Teacher*	Level	Formal/ Informal	Type of Record	Method of Assessment
A-2	P 4-7	Informal	Folders of work	Comments on work and pupil conferences
B-2	P 4/5	Formal	Individual sheets	Comments relating to objectives
C-2	P 4/5	Formal	Individual check-list	Five criteria levels checks and comments
D-3	P 6	Formal	Individual and group checklists	Criterial level checks and comments
F-2	P 6	Formal	Individual check-list	Three criteria level checks and comments
G-2	P 7	Informal	Comment sheet per child	Five inquiry objectives & attitudes & social behaviour
H-1	P 4/5	Formal	Group assessment sheet and profile sheets	Five criteria level checks and comments
H-2	P 6/7	Formal	Group assessment sheet and profile sheets	Five criteria level checks and comments

* Names of teachers and schools are confidential.

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APPENDIX

SUMMARY OF TEACHERS' TYPES AND RECORDS OF ASSESSMENT

A-1 This teacher had the children, even the very youngest, write and/or draw the story of each investigation. She watched them as they worked and used the sheets as well as their oral comments to measure their achievement. Discussion and reteaching followed when needed. Their sheets were kept in a folder. Details of her work are found in Case Study #1.

B-1 Teacher B-1 had difficulty in coming to terms with assessment of primary science although she was running a fine science program. She eventually decided to keep a record book with the children's names in it and write critical comments on those children's work which she considered significant for that particular activity, i.e., had great difficulty with a concept or skill, had done exceptionally well, or had brought some contribution from outside school relative to the topic.

C-1 This teacher developed a group checklist on which the concepts, skills and attitudes were listed. She used a three levels of success set of criteria and wrote additional comments when necessary. She had initially designed a checklist to be used with each child, but after using it for a time, decided that it was too time consuming.

D-1,2 These teachers had been working in a teaming situation for some time, so that all their planning was done together. They designed their unit especially to be used with its accompanying assessment. They drew up detailed group comment sheets and checklists which will be described in Case Study #2.

E-1 A group checklist was the technique used by this new teacher. She planned the unit and the assessment together. She used a group checklist with the concepts listed and wrote in comments on each child's success in learning the concepts. The details of her work will be described in Case Study #3.

F-1 This teacher had difficulty initially understanding what was wanted for this research project with respect to the science content and the assessment aspect. In spite of much discussion and deliberation she did not find that she could bring herself to do any written assessment even though she was teaching a fine science program. She believed that she could keep all the assessment details in her head. She did say, however, that the project had heightened her awareness of each child's learning.

G-1 A detailed and comprehensive plan was developed by this teacher along with her assessment method. She used a checklist to assess her pupils' ability in researching, recording, experiencing and feeling, and interpreting experiencing, as well as concepts and attitudes/

qualities. She tried this checklist out with one group only and completed it after the work on each subtopic was finished. She plans to use it next year with a different group per topic.

A-2 This Head Teacher from a very small school had from P4 to P7 levels in her class. For science she had the children perform science investigations, complete work sheets and write up reports. She monitored their work closely, and put comments on their work as well as had conferences with individual students as the need arose. Examples of this method will be described in Case Study #1

B-2 Teacher B-2 had difficulty in coming to terms with assessment techniques. Initially she felt that no written assessment was necessary. Subsequently she tried out a checklist for each child, but determined that this method did not suit her. Towards the end of the term she decided that she would use a record book with the children's names and place comments relative to each objective of the science unit.

C-2 This teacher developed a checklist of process skills, communication skills, and manipulative skills to be used for each child. She decided to have five criteria level checks and comments. She may modify it later.

D-3 An elaborate system of individual and group checklists and comment sheets was developed by this enthusiastic teacher. Her work will be illustrated in Case Study #3.

F-2 This new teacher developed a pupil checklist for every student, listing science processes, communication skills, manipulative skills, and attitudes. Because her unit was nearly finished when she began her assessment, she was only able to try it out a few times. She plans to modify it for use next year.

G-2 Because of the age of the pupils, P7's, this teacher decided to assess their abilities to use inquiry procedures (divided into five objectives) as well as note their attitudes and social behaviour. She wrote comments on these aspects on separate sheets for each child.

H-1 An environmental studies profile was designed for each pupil in which concepts, skills, and attitudes were checked on a five point criteria scale. As well as this a group assessment sheet was developed and a pupil scientific report sheet. All will be described in Case Study #4.

H-2 This teacher used the materials used by teacher H-1. Their use will be described in Case Study #4.